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U. S. DEPARTMENT OF AGRICULTURE.
DIVISION OF ENTOMOLOGY.
BULLETIN NO. 11.

REPORTS OF EXPERIMENTS

WITH

VARIOUS INSECTICIDE SUBSTANCES,

CHIEFLY UPON

INSECTS AFFECTING GARDEN CROPS,

MADE

UNDER THE DIRECTION OF THE ENTOMOLOGIST.

DEPARTMENT OF AGRICULTURE

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LETTER OF SUBMITTAL.

DEPARTMENT OF AGRICULTURE,
DIVISION OF ENTOMOLOGY,
Washington, D. C., January 14, 1886.

SIR: I have the honor to submit for publication Bulletin No. 11 of this Division, which contains in condensed form the results of a series of experiments with insecticides, carried on by certain agents of the Division during the past summer.

Respectfully,

C. V. RILEY,
Entomologist.

HON. NORMAN J. COLMAN,
Commissioner of Agriculture.

EXPERIMENTS WITH INSECTICIDES.

INTRODUCTION.

There are a number of remedies against insects, which have been proposed from time to time, and which have been published without any definite record of experiment, their reputation resting upon hearsay evidence. The list of such remedies is growing longer every day, and with a view of testing some of those which are most frequently recommended, in order to enable us to speak with definiteness concerning their value, we prepared a list early in the summer and sent duplicates to two of our agents, Prof. H. Osborn, at Ames, Iowa, and Mr F. M. Webster, at La Fayette, Ind. At the same time, being desirous of testing the infusions and decoctions of certain plants popularly supposed to have insecticide properties, we engaged Mr. Thomas Bennett, of Trenton, N. J., a practical gardener of many years' experience, to experiment in this direction. The reports of these three gentlemen are subjoined, and their results, though in the main negative, are nevertheless of considerable interest and value.

KEROSENE WITH MOLASSES.

It will be noticed that the kerosene emulsion used by Messrs. Webster and Osborn was made of equal parts of kerosene, molasses, and water. This method of making an emulsion was first suggested to us by Mr. E. S. Goff, of the New York agricultural experiment station at Geneva, N. Y., early last August. Mr. Goff had made what he thought a tolerably perfect emulsion with these substances by using a crude sorghum molasses, and his experience at once interested us on account of the fact that the mixture was made without heat, and because of the probability that the molasses would render the dilute emulsion more or less adhesive. After a long series of experiments, however, Mr. Goff came to the conclusion that he had overestimated the value of the preparation. We quote from his last letter on the subject:

"I write to say that after abundant experimenting with the molasses-kerosene emulsion, of which I wrote to you in August last, I fail to find it equal to the soap emulsion. By boiling the molasses and water and

adding the kerosene to the hot solution, a very fair emulsion may be made, but on standing, a fermentation seems to take place which causes it to separate, and after that it will not remain mixed. The unexpected success of my first attempt with the very thick sorghum molasses led me to premature and unwarrantable conclusions."

Following out the first suggestion, Professor Osborn found it impossible to make a stable emulsion from the cold mixture of equal parts of molasses, kerosene, and water, using ordinary low-grade New Orleans molasses, no matter how violent and prolonged the agitation. In from fifteen to twenty minutes, at the most, the oil would almost entirely separate from the mixture, rendering necessary its immediate use after preparation.

COLD WATER AND CABBAGE WORMS.

In addition to the results of the experiments with cold water as a remedy for cabbage-worms, as given by both Professor Osborn and Mr. Webster, we have received several communications since our publication early in the summer, in the columns of the *Rural New Yorker*, of the suggestion* which originally came to us from Mr. C. H. Erwin, of Painted Post, N. Y. All of these communications are condemnatory of the remedy. We extract from one (written by Mr. E. S. Goff) an experiment which is worthy of publication in this connection:

> In experimenting with ice-water for the cabbage caterpillars I tried to intensify the conditions as much as possible. I immersed leaves having the caterpillars upon them in ice-water, leaving them there a quarter of a minute. I then removed the leaves to a bench on the west side of the house, about 3 o'clock p. m., on a very hot day. The temperature must have been at least 100 degrees. Half an hour later I examined them and found the leaves very much withered and becoming brown from the heat, but the worms had crawled to the rear side and were exhibiting no inconvenience.

In our article just mentioned we left the question as to the efficacy of the remedy open to experimenters, but the positiveness of Mr. Erwin's assurances, and the thorough, careful tone of his letter, inclined

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* The text of this suggestion was as follows:

"Mr. Charles H. Erwin, of Painted Post, N. Y., has accidentally hit upon a simple and yet, according to his experience, so perfect a remedy for the imported cabbage worm that I wish to give his experience as much publicity as possible, that it may be widely tested, and, if possible, verified the coming season. It is (to sum up an extended experience which he narrated) simply ice-cold water, or water but a few degrees warmer than ice-water, sprinkled upon the worms during the heat of the day. Mr. Erwin found that such an application in the hot sun caused them to quickly let go their hold upon the leaves, curl up, roll to the ground and die, while the cabbage suffered nothing, but looked all the fresher for the application. Should this method prove as successful with others as it has with him, it is evident that we have here a remedy of very general application, and one which in cheapness and simplicity far transcends the pyrethrum, which, since I first discovered its value for the purpose in 1880, has been, on the whole, our safest and most satisfactory remedy against *Pieris rapae*. Where ice is readily obtainable, as in the more northern States, or where cold springs are found, Mr. Erwin's discovery will prove of very great value to cabbage-growers, and will prove as useful against some other cabbage worms."

us to believe that there might be something in the remedy. When these adverse reports came in we wrote to Mr. Erwin to inquire whether he had made further experiments and for further evidence. He replied as follows, August 23, 1885:

I received last Thursday evening your assistant's (L. O. Howard) report of your unsuccessful trial of the "cold-water remedy" for cabbage worms. I have since called upon two old gardeners in the vicinity, who had used it. Mr. Thomas Homer was the only one whom I found at home, and he was ill. When I told him the result of your experiments he interrupted me by saying: "They have not used very cold water, or have used a rose-sprinkler when they should have thrown away the rose and used the spout. I have used ice-water, and it would make them turn white and would not hurt the plants. Deacon Farwell used to make me use ice-water and drench the plants at noon or in the hottest part of the day. I have used nothing else for many years, and have lost scarcely a head of cabbage since I used it." I have in answer quoted this honest old Scotch gardener for the reason that for the last three or four years I have not worked in or done any gardening for myself. I used to drench my plants every few days, always in the warmest part of the day, or about the time the pests were the most active and destructive—when they were on the upper side of the leaf—and have been told by others that they have succeeded after the worms had filled every crevice with their droppings and rejected chippings, which they had by drenching cleaned out; and here you discover is another benefit and argument for a copious shower of water.

Possibly those who have experimented have, through fear of injuring the plants, hesitated to use water cold enough or have used it too sparingly and in the cooler part of the day. In making the discovery I was too late to avail myself of caution about the safety of the plant, and was compelled to solace myself with the idea that if the cold had injured and killed them I was not in a worse predicament than before using the cold water, for if I had killed the plants I had only anticipated a few days the certain result of the pests.

Perhaps the vermin are of a tougher habit in a warmer climate, and I would not hesitate to reduce the temperature of the water another degree or two and be sure of the top degree of the day to apply it.

Several persons have told me that they used it last season with success, and one person that he had not been troubled this season, not yet having discovered any worms; but until recently but few persons in our vicinity grew more than a hundred plants. This season I have noticed not a few acres planted with cabbages.

Please have your tests made properly and in the right time, and I think you will succeed. It may seem too simple to be of much benefit, and scarcely worth the trial, and single efforts may fail for want of a little care. Let them act as if there should be no such thing as failure, and they will succeed. Drench more frequently.

In view of such positive statements on both sides we cannot consider the question as decisively settled yet, but a pretty strong case is made against the remedy in the reports which now follow.

C. V. RILEY.

REPORT OF EXPERIMENTS AT LA FAYETTE, INDIANA.

By F. M. Webster.

I.—Imported Cabbage Worm. (*Pieris rapæ* Sch.)

Experiment 1.—ICE WATER.

(August 4, 1885.)

Temperature of atmosphere about plants, 99° F. Temperature of water, 40° F. Drenched two cabbage plants, now well headed and seriously infested.

Result.—None perceptible.

Experiment 2.—ICE WATER.

Temperature of atmosphere, 104° F. Temperature of water, 38° F. Drenched two plants.

Result.—None are injured, and only seem to have been displaced.

Experiment 3.—ICE WATER.

August 4, 1885.—Temperature of atmosphere, 98° F. Temperature of water, 36° F. Drenched plants as before.

Result.—A number were washed off, but none died from the effects of their cold bath.

Experiment 4.—ICE WATER.

Temperature of atmosphere, 98° F. Temperature of water, 34° F. Plant seriously infested, larvæ from $\frac{3}{8}$ inch long to full grown. Drenched at 1.45 p. m., September 11, 1885, by pouring one quart water on head of plant, thoroughly wetting all larvæ visible.

Result.—At 5 p. m. all worms have returned to the leaves and are actively feeding.

Experiment 5.—ICE WATER.

Temperature of atmosphere, 96° F. Temperature of water, 34° F. September 19, 12.45 p. m., poured water from pitcher on two plants.

Result.—On one plant, worms, even the smallest, $\frac{1}{2}$ inch long, were uninjured; on the other two small worms were found dead soon after.

These were discolored when found, and I cannot say whether they died from the effects of water or from an epidemic disease that is destroying these larvæ in great numbers; some on this same plant being affected and afterwards died, and I think the latter more probably the cause.

EXPERIMENT 6.—SALT WATER.

August 5.—Dissolved salt in water to fullest capacity. Drenched a number of plants badly infested with larvæ.

Result.—On examination, 24 hours after application, I find no dead larvæ, but the living are feeding in abundance.

EXPERIMENT 7.—SALTPETER AND WATER.

Dissolved in water to fullest capacity. Drenched plants thoroughly.

Result.—Examined 24 hours after application, but find none dead, nor any diminution in the numbers of the living, which are feeding as usual.

EXPERIMENT 8.—CARBOLIC ACID AND WATER.

Solution of 1 part acid to 100 parts water. Drenched two plants.

Result.—This injured both plants, one quite seriously, by killing the younger, tender leaves, while such of the larvæ as were protected by these leaves did not seem to have suffered.

EXPERIMENT 9.—PYRETHRUM POWDER.

A mixture of one part of powder to three parts flour was thoroughly dusted on plants with Woodason's powder bellows, care being taken to get the mixture thoroughly introduced among the leaves and cavities eaten out by the larvæ.

This experiment was made in order to establish a basis from which to judge of the efficiency of other insecticides. I will further state that the pyrethrum powder used was sent me from the Department last season (1884), and had been kept in a glass jar closely corked.

Result.—Fully three-fourths of the larvæ were killed.

EXPERIMENT 10.—WOLF'S SOAP.*

Solution of 1 ounce soap dissolved in ½ gallon of water, applied at a temperature of 90° F., by drenching plants thoroughly, first wetting them with water, and drenching them with same a short time after application of solution.

Result.—At least one-half of the worms were killed and the plants not injured.

EXPERIMENT 11.—WOLF'S SOAP.

Solution as in 10. Sprayed lightly on several full-grown larvæ and confined them under glass.

Result.—None died.

* Manufactured by the Milwaukee Soap Manufacturing Company, Milwaukee, Wis.

EXPERIMENT 12.—WOLF'S SOAP.

Solution, 3 ounces soap to 1 gallon water; temperature 90°. Sprayed on plants with the Woodason atomizer.

Result.—Seems to have been rather more effective than in experiment 10.

EXPERIMENT 13.—WOLF'S SOAP.

Solution as in Experiment 12. Drenched plants thoroughly.

Result.—Does not seem to have been any more effective, although a much larger amount of the solution was used. The spraying method seems the more satisfactory.

EXPERIMENT 14.—WOLF'S SOAP.

Solution, 4 ounces soap dissolved in 1 gallon water. Sprayed on wet surface of leaves and head.

Result.—Killed a large number of the larvæ, but by no means all of them.

EXPERIMENT 15.—BUCKWHEAT FLOUR.

Dusted the article usually put up for family use on a number of infested plants.

Result.—The larvæ did not seem to suffer any inconvenience.

EXPERIMENT 16.—BUCKWHEAT FLOUR.

Placed 11 larvæ in some of this same flour, and covered with glass.

Result.—Forty-eight hours after, none had died, while some had climbed to top of glass and pupated.

EXPERIMENT 17.—AMMONIA AND WATER.

Solution of 3 tablespoonfuls of ammonia to 1 gallon of water. Applied with syringe.

Result.—None were injured by the application.

EXPERIMENT 18.—POWDERED ALUM.

Applied to dew-wet leaves at 8.10 a. m., abundantly.

Result.—Cannot see that any are destroyed.

EXPERIMENT 19.—COPPERAS AND WATER.

Dissolved one-half ounce copperas in 1 pint water; drenched several plants.

Result.—This only seemed to cause the worms to seek less exposed positions. Watched for a number of days, but found none dead.

EXPERIMENT 20.--BLACK PEPPER.

Applied the ground article of commerce copiously to two heads of cabbage.

Result.—I could not see that it affected those which came in contact with it, and all continued to feed as though no application had been made.

EXPERIMENT 21.—CARBOLIZED LIME MIXTURE.

Mixture of carbolized lime 1 part, quick lime ¾ part, gypsum 20 parts. Dusted mixture on two plants.

Result.—Twenty-four hours after, the worms were crawling about on the leaves, feeding, and although some of the powder adhered to their bodies, I saw no fatal results.

EXPERIMENT 22.—TAR WATER.

Sprayed on plants.

Result.—None apparent.

EXPERIMENT 23.—TOMATO WATER.

Steeped leaves of tomato vines, and applied strong decoction.

Result.—As in preceding.

EXPERIMENT 24.—ARKANSAS INSECTICIDE.*

Placed 24 larvæ on leaf of cabbage, and dusted both leaf and worms thickly with the insecticide, at 10.25 a. m., August 25. The leaf and worms were confined under a glass.

Result.—At 10.25 next day, they seemed to be feeding from some parts of the leaf not covered with insecticide. August 27, they did not seem to relish the leaf with the insecticide thereon, but found enough not at all or thinly covered to keep them alive. This is not of practical utility for large plants, but might do on those very young.

EXPERIMENT 25.—ARKANSAS INSECTICIDE.

Tested this thoroughly on plants, with results like those on leaf under cover. In this experiment the larvæ were watched closely for a period of four days.

EXPERIMENT 26.—SOLUBLE PINOLEUM.†

Solution of 1 part pinoleum to 40 parts water, sprayed copiously on plants in garden, August 25.

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*Manufactured by Hoag & Beecher, Judsonia, Ark.

†Manufactured by Hansen & Smith, Wilmington, N. C.

A sample of this "soluble pinoleum" was also sent to our agent at Cadet, Missouri, Mr. J. G. Barlow, who reported in brief, as follows: "Have experimented a little with the soluble pinoleum sent to me by your desire from North Carolina. I found that a solution of one part to 10 of water was not too strong for larvæ of

Result.—On 27th, not over 25 per cent. of worms were destroyed. Living worms abundant, showing no effects whatever.

EXPERIMENT 27.—SOLUBLE PINOLEUM.

Solution the same as in experiment 26. Placed larvæ on a leaf, thoroughly spraying the same.

Result.—The larvæ, with the exception of two small ones, survived, and devoured the leaf.

EXPERIMENT 28.—SOLUBLE PINOLEUM.

Solution, 5 parts insecticide to 100 parts water. Sprayed on plants in garden, September 2.

Result.—On 4th, a large number of larvæ of various sizes were alive and active, about 40 per cent. apparently having been destroyed.

Before further experiments could be made the larvæ began to die from effects of disease, and it was impossible to carry on the experiment and get definite results.

EXPERIMENT 29.—KEROSENE EMULSION.

An emulsion consisting of equal parts of kerosene, molasses, and water, was diluted with three times its volume of water. Syringed plants on September 7. Rain during night. Sprayed with same mixture again, September 10.

Result.—September 8, 80 per cent. of all worms exposed were destroyed. The result of second application could not be definitely determined, as many were dying from disease.

I do not think younger plants would withstand emulsion of this strength, but it would probably not be required for younger larvæ.

EXPERIMENT 30.—CARBOLATE OF LIME.

Dusted plants thoroughly with carbolate of lime, using the Woodason bellows.

Result.—Two days after, both large and small were still on the plants, with no dead to be found.

EXPERIMENT 31.—HAMMOND'S SLUG SHOT.*

Dusted insecticide thickly over the plants with powder bellows, September 11. Rain fell on 13th. Dusted again on 14th.

Result.—September 12, quite a number were found dead.

Noctuids and Pieris. The solution in these proportions will kill these larvæ in from one to two minutes. Plant-lice it will kill instantly. Tried several specimens of the larvæ of *Sphinx quinquemaculata*, and found to my surprise that not even the solution in full strength would kill them. I think the pinoleum will be useful as an insecticide, but not if mixed with so much water as the proprietors direct."—C. V. R.

*Manufactured by B. Hammond, Fishkill-on-Hudson, N. Y.

Of the first result I can only say that all larvæ died from disease shortly after, and at this date (October 19) the fact is clearly noticeable in the leaves, those appearing previous to about the 15th are badly eaten, while those that were put forth after that date are almost intact.

On October 1, the difference between the plants treated with slug shot and those not treated was very apparent in the much more thrifty look of the former, and the larger number of perfect leaves, and this difference is still very perceptible.

Just what per cent. of leaves was killed by insecticide, it is of course impossible to determine, but the plants have a better look.

II.—Native Cabbage Worm. (*Pieris protodice* Boisd.)

Experiment 1.—HAMMOND'S SLUG SHOT.

Upwards of 50 larvæ, taken from leaves of turnip, were placed in a cage, and leaves, slightly dusted with the insecticide, placed therein.

Result.—Two days after, many were dead and others were dying. On the third day nearly all were dead. Eventually but 5 pupated. The single meal of dusted leaves proved sufficient, although ample food not dusted was afterwards supplied them.

III.—Fall Web-Worm. (*Hyphantria textor* Harris.)

Experiment 1.—WOLF'S SOAP.

Solution of 1 oz. soap to half gallon water; temperature, 90° F. sprayed with atomizer on foliage adjacent to web; also in web, wetting same quite thoroughly, nearly all of the caterpillars being within.

Result.—Two days after application, about 60 per cent. were found to have been destroyed. The foliage which had been sprayed did not appear to suffer for about three days, when the caterpillars again returned to it and ate the leaves as though they had not been treated.

Experiment 2.—POTASSIUM SULPHIDE.

Solution, 1 part sulphide to 500 parts water; applied to web and foliage with garden syringe.

Result.—On following day, a small per cent. appeared to have been destroyed, but a week later the effects of the experiment could not be noticed. Does not seem to render the foliage distasteful.

Experiment 3.—COPPERAS WATER.

Dissolved 1 oz. copperas in one pint of water; drenched web, and thoroughly wetted foliage.

Result.—One day after, many caterpillars were dead and others scattered about in the web, seemingly very sick. Five days after, the foliage remains untouched and all are dead.

EXPERIMENT 4.—COPPERAS WATER.

Dissolved 1 oz. in 1 quart of water. Used as in previous experiment.
Result.—It does not seem to have affected the larvæ.

EXPERIMENT 5.—TAR WATER.

This water had been standing for several days in a cask partly filled with tar. Water applied with syringe, wetting larvæ and foliage.
Result.—On first day after, none appeared to have been injured, and many were feeding. Five days after, the results were as on the first.

EXPERIMENT 6.—AMMONIA WATER.

Solution of 1 tablespoonful to 1 pint water. Drenched as in experiment 5.
Result.—First day after application, none injured. Five days after, the situation is unchanged.

EXPERIMENT 7.—CARBOLIZED WATER.

Solution, 1 part carbolic acid to 128 parts water. Drenched web thoroughly.
Result.—First day after application, none injured. Five days after, situation unchanged.

EXPERIMENT 8.—TOMATO INFUSION.

Drenched web with strong infusion.
Result.—First day after application, none injured. Five days later, no change.

EXPERIMENT 9.—CARBOLATE OF LIME.

Dusted young larvæ and the leaves on which they were feeding, thoroughly.
Result.—First day after application, a few seem to be dead. Second day, not over 10 per cent. were injured.

EXPERIMENT 10.—SOLUBLE PINOLEUM.

Solution of 1 part pinoleum to 32 parts water. Sprayed several colonies and also adjoining foliage.
Result.—After four days all seem to be active, except a small per cent. that were drenched more thoroughly than the rest.

EXPERIMENT 11.—POTASSIUM SULPHIDE.

Solution of 1 part sulphide to 500 parts water. Sprayed on young caterpillars less than one-half inch long.
Result.—None were destroyed.

IV.—Colorado Potato-Beetle. (*Doryphora 10-lineata* Say.)

Experiment 1.—WOLF'S SOAP.

Solution, 1 ounce to 1 gallon of water. Temperature normal. Sprayed on a number of adults.

Result.—Twenty-four hours after, none were injured.

Experiment 2.—WOLF'S SOAP.

Solution and temperature same as in Experiment 1. Sprayed larvæ of various sizes about as I would apply Paris green and water.

Result.—Only a small number of the youngest were destroyed.

Experiment 3.—WOLF'S SOAP.

Solution of 3 ounces to 1 gallon of water, applied to nearly full-grown larvæ on potato vines.

Result.—Nearly all were alive next day.

Experiment 4.—WOLF'S SOAP.

Solution of 3 ounces to 1 gallon of water. Sprayed on tomato vines being eaten by nearly full-grown larvæ and adults.

Result.—Two hours after, both larvæ and adults had left the vines, but I found no dead. Three days after, adults were again feeding on the same vines, but no larvæ were observed to return.

Experiment 5.—AMMONIA AND WATER.

Solution of 3 tablespoonfuls of ammonia to 1 gallon water. Sprayed on plants infested by larvæ of various sizes.

Result.—One day after, only a very few of the youngest larvæ had been destroyed.

Experiment 6.—AMMONIA AND WATER.

Solution as in Experiment 5. Placed enough of this mixture in glass to cover bottom; put in glass nearly full grown larvæ and beetles, shook thoroughly, turned off fluid and insects and inverted the glass over them.

Result.—Not a single larva or adult was injured.

Experiment 7.—AMMONIA AND WATER.

Solution, 1 tablespoonful to 1 quart of water; applied as in Experiment 6.

Result.—The same as in previous experiment.

Experiment 8.—CARBOLATE OF LIME.

Sprinkled thickly on tomato vines that were being eaten by adults and larvæ.

Result.—Twenty-four hours after application the insects had apparently deserted the vines, but I found none dead.

EXPERIMENT 9.—CARBOLATE OF LIME.

Sprinkled larvæ and adults with carbolate of lime, and placed under glass.

Result.—None died.

V.—STRIPED CUCUMBER BEETLE. (*Diabrotica vittata* Say.)

EXPERIMENT 1.—WOLF'S SOAP.

Solution, 3 ounces to 1 gallon water, applied at normal temperature, to adults.

Result.—After 6 hours none appeared injured.

EXPERIMENT 2.—CARBOLATE OF LIME.

Dusted on male blossoms of squash in which six adults were feeding on the pollen.

Result.—Two days after, they were dead in the blossom.

VI.—MARGINED BLISTER BEETLE. (*Epicauta cinerea* Forst.)

EXPERIMENT 1.—TAR WATER.

Applied to a row of mangel wurzels, seven rods in length, which was being seriously defoliated by this insect.

Result.—Five hours after, only an occasional plant was being eaten.

EXPERIMENT 2.—WOLF'S SOAP.

Applied solution of 3 ounces of soap to 1 gallon of water to a row of mangel wurzels beside that used in Experiment 1.

Result.—Five hours after, only three beetles were found on the leaves, but none were found dead or injured.

EXPERIMENT 3.—COPPERAS WATER.

Solution, 1 ounce to 1 pint water sprayed on row next to Experiment 2.

Result.—Five hours after, the number of beetles feeding on leaves does not seem to have diminished.

NOTE.—Three days after, the beetles had returned to all three rows in about equal numbers.

VII.—ANTS.

EXPERIMENT 1.—CARBOLIC ACID.

Large numbers of ants had excavated burrows between the crevices of a brick walk in my yard, and kept the entire walk in an unsightly condition by reason of the numberless little circular heaps of excavated

earth. To these burrows I applied about a tablespoonful of a solution of 1 part carbolic acid to 64 parts water.

Result.—No ants appeared in the burrows, and no attempt was made to re-establish these burrows again.

About two weeks later, a few burrows were excavated in the crevices, and these were treated in the same manner. The results were as favorable as before, and up to date (October 20), no ants have attempted to work in crevices of the walk.

EXPERIMENT 2.—CARBOLIC ACID.

Solution of 1 part acid to 128 parts water was applied to burrows, about two-thirds of a tablespoonful to each burrow.

Result.—In some cases, 24 hours after application, the ants had returned to work in the old burrows, but in most cases the burrows showed no signs of life.

EXPERIMENT 3.—CARBOLIC ACID.

Solution of 1 part acid to 96 parts water, applied as in Experiments 2 and 3.

Result.—Only in a single instance was any attempt shown to dig out the old burrows, and about this were a large number of dead ants that had been removed in re-excavations.

A few attempts to excavate burrows in the vicinity of the old ones were observed a few days after first application, but these burrows were drenched as before, and no attempt was afterwards made to excavate between the crevices in that vicinity.

EXPERIMENT 4.—COPPERAS WATER.

Solution of 1 ounce to 1 pint water was poured into the burrows.

Result.—Next day the ants were busily engaged in clearing out the old burrows.

EXPERIMENT 5.—AMMONIA WATER.

Solution of three tablespoonfuls to one gallon water was used, as in previous experiments.

Result.—Same as in Experiment 4.

EXPERIMENT 6.—TAR WATER.

Drenched as in previous experiments.

Result.—The ants did not attempt to clear out the old burrows, but excavated others close behind them.

VIII.—LETTUCE APHIS. (*Siphonophora lactucæ* Linn.?)

EXPERIMENT 1.—SALT WATER.

Dissolved salt in water to its full capacity. Sprayed solution on lettuce plants infested, the aphids being on upright stalks and hence easily reached.

Result.—About 50 per cent. were killed. A second application on the following day was fatal to nearly all of the remainder, and to the plant also.

Experiment 2.—WOLF'S SOAP.

Solution of 3 ounces soap to 1 gallon of water. Sprayed on aphids on plants.

Result.—Thoroughly effective.

IX.—Wooly Aphids. (*Species various.*)

Experiment 1.—WOLF'S SOAP.

(Species on Tree-Ferns in green-house.)

Solution of 4 ounces soap to 1 gallon of water. (Temperature normal.) Sprayed on foliage previously wetted; drenched with water soon after application of solution.

Result.—This made no impression on the insects.

A second application after 24 hours had elapsed from first.

Result.—Only a small per cent. were destroyed.

A third application, the foliage not being sprinkled with water after application of solution, proved fatal to the aphids and killed the entire foliage of the plant.

Experiment 2.—TAR WATER.

Wooly Aphis of Apple. (*Schizoneura lanigera* Hausm.)

Tar water sprayed on infested branches, August 31.

Result.—September 2, does not seem to have had the least effect.

Experiment 3.—SOLUBLE PINOLEUM.

Species as in Experiment 2. Solution of 5 parts pinoleum to 100 parts water. Sprayed on branches with atomizer.

Result.—On following day, many active lice were observed. Three days after, they were abundant, and five days after, were as abundant as at first.

Experiment 4.—SOLUBLE PINOLEUM.

Species as in Experiments 2 and 3. Solution of 15 parts pinoleum to 82 parts water. Sprayed on branches, September 15.

Result.—Three days after application, none were to be found, and up to October 20, none have appeared on these branches.

Experiment 5.—KEROSENE EMULSION.

(*Glyphina eragrostidis* Middleton.)

An emulsion, composed of equal parts kerosene, molasses, and water, was diluted with three times its volume of water. This was sprayed on aphids, September 12.

Result.—September 13, found hardly a trace of aphids. September 16, a very few have appeared. September 25, they have spread over the grass, and are as abundant as ever.

EXPERIMENT 6.—SOLUBLE PINOLEUM.

Solution of 5 parts pinoleum to 100 parts water, sprayed on same species, September 3.

Result.—September 4, none appear affected and none are destroyed.

X.—APPLE APHIS. (*Aphis mali* Fabr.)

EXPERIMENT 1.—SOLUBLE PINOLEUM.

Solution of 15 parts pinoleum to 85 parts water. Sprayed on twigs and leaves.

Result.—The aphids were completely destroyed.

XI.—APPLE LEAF SKELETONIZER. (*Pempelia hammondi* Riley.)

EXPERIMENT 1.—SOLUBLE PINOLEUM.

Solution of 15 parts of pinoleum to 85 parts of water. Sprayed over leaves, September 15.

Result.—Probably 75 per cent. of the larvæ were destroyed, but full-grown larvæ were observed on leaves, October 1st.

EXPERIMENT 2.—HAMMOND'S SLUG SHOT.

Dusted leaves seriously affected by larvæ, September 15, when no dew was on them.

Result.—September 16, 50 per cent. are dead. Dusted again, on 17th, on dew-wet leaves. October 1, not one living larva could be found on the leaves that had been dusted, while numbers were on leaves not treated. September 26, nine days after, a larva established itself on one of the dusted leaves, ate a very small spot on the leaf, and died.

XII.—YELLOW-NECKED CATERPILLAR. (*Datana ministra* Dru.)

EXPERIMENT 1.—POTASSIUM SULPHIDE.

Solution of 1 part potassium to 500 parts water. Sprayed on larvæ feeding on walnut.

Result.—The larvæ were uninjured.

EXPERIMENT 2.—POTASSIUM SULPHIDE.

Solution as in 1. Applied to larvæ clustered on trunk of tree, preparatory to molting.

Result.—The larvæ molted, and ascended the tree. I could not see that the application had the slightest effect.

EXPERIMENT 3.—WOLF'S SOAP.

Solution, 4 ounces to 1 gallon of water. Sprayed on larvæ feeding on walnuts.

Result.—The larvæ only changed their location for a branch higher up.

EXPERIMENT 4.—COPPERAS WATER.

Solution of 1 ounce to 1 pint of water. Sprayed two colonies of nearly full-grown worms.

Result.—This seemed to destroy a very few larvæ, and the remainder changed their location on the tree.

EXPERIMENT 5.—COPPERAS WATER.

Solution as in Experiment 4. Sprayed cluster on trunk of tree.

Result.—They molted, and ascended the trunk and began feeding.,

EXPERIMENT 6.—SOLUBLE PINOLEUM.

Solution of 1 part pinoleum to 32 parts water. Sprayed one cluster on leaves and another on trunk.

Result.—There appears to be some reduction in the numbers of those feeding, and those on trunk were destroyed.

EXPERIMENT 7.—SOLUBLE PINOLEUM.

Solution of 5 parts of pinoleum to 100 parts water. Sprayed half grown larvæ on branch high up in tree, so that I could only give them a slight wetting.

Result.—None were injured, and, two days after, they were feeding as though nothing had happened.

EXPERIMENT 8.—SOLUBLE PINOLEUM.

Solution of 15 parts to 85 parts water. Sprayed copiously on cluster on trunk of walnut tree.

Result.—About 50 per cent. were killed, some dying after the second day. The cluster became detached from the tree and fell to the ground, but a few larvæ detached themselves from it, and again ascended the tree, and molted.

EXPERIMENT 9.—AMMONIA WATER.

Solution of 1 tablespoonful to 1 pint of water. Sprayed cluster on trunk of tree.

Result.—They molted and ascended the tree.

EXPERIMENT 10.—KEROSENE EMULSION.

An emulsion, of equal parts kerosene, molasses, and water, was diluted with three times its volume of water. Sprayed on cluster on trunk of tree.

Result.—Not over 20 per cent. molted, and many of these died before ascending the tree.

EXPERIMENT 11.—KEROSENE EMULSION.

Emulsion the same as in 10. Sprayed on caterpillars on leaves and twigs in walnut tree.

Result.—All disappeared within forty-eight hours after application.

EXPERIMENT 12.—HAMMOND'S SLUG SHOT.

Dusted leaves on which nearly full-grown larvæ were feeding.

Result.—The worms changed their position soon after to a distant branch, but their route was clearly indicated by occasional dead larvæ hanging to the branch along which they had crawled, and soon after all disappeared.

REPORT OF EXPERIMENTS AT AMES, IOWA.

By Prof. Herbert Osborn.

Sir: I send you with this a summary of my tests of various remedies for cabbage insects, &c. My work has been almost entirely confined to cabbage pests, as some of the insects mentioned in your instructions had already passed the active stages, while some mentioned have not appeared in this locality. There are no gardens worthy the name in the vicinity, so that some of the most common vegetables, with the insects infesting them, have not been within my reach. Even cabbages were rather scarce this year. One patch of about eighty plants, on the college farm, was quite well stocked with insects—*Pieris rapæ*, *Plusia brassicæ*, *Plutella cruciferarum*, *Aphis brassicæ*, *Haltica striolata*, &c. Another patch on the college farm, containing a greater number of plants, contained scarcely one with a solid head, and they were so poor that the insects seemed to consider them beneath notice. Scarcely a cabbage worm could be found there during the entire fall.

A small patch of about eighty plants, on a farm owned by Professor Mount, was quite free from worms till the 1st of October, after which they were more plentiful, and served for experiments with several substances. The small number of plants necessitated experimenting on a few for any one substance, and going over the same plants with other remedies after the lapse of a few days, sufficient to note results.

The appearance of the epidemic disease among the cabbage worms, mentioned in connection with the cold-water experiments, made it necessary to be very careful in judging of results. It commenced about the middle of September, and continued till all the worms disappeared, great numbers dying from it, though all the plants in a patch would not be found to contain diseased worms at the same time (at one time a great many dead or diseased worms could be found at one end of the patch and none at the other). The characteristic appearance of the worms dying of this disease makes it easy to distinguish them for a time after death, but later they turn dark and shrivel, and do not differ much from worms that have been killed by parasites or predaceous insects or by application of remedies. Parasites have been quite abundant, both in Aphides and worms. Coccinella larvæ and adults, Syrphus larvæ, and Ichneumons were on hand, and I noticed one cabbage worm im-

paled on the beak of a soldier-bug, and others which appeared to have had their life extracted by the same foe. Altogether the worms and Aphides have had a hard time. Only a small proportion of *Pieris rapæ* could have pupated in a healthy condition.

Concerning the cold-water remedy, to which you desired me to give particular attention, my tests, while not crucial, for the reasons stated, satisfy me that it has no direct effect on the worms. I applied the water ice-cold (at one time with temperature of air above 80° F.), so as to thoroughly soak many of the worms which I could see, and in one instance I placed lumps of ice on a couple of cabbages so as to come in contact with worms, and so that the water running from these lumps would give them a cold bath for some time, but could not discover any worms dead from its effect. However, the worms on the plants treated with the ice water died off very rapidly with the micrococcus disease, and I think it possible that the treatment made them fall an easier prey to this epidemic.

Respectfully,

HERBERT OSBORN.

Prof. C. V. RILEY,
U. S. Entomologist.

TESTS OF REMEDIES.

Kerosene and Molasses Emulsion.—Made by shaking together violently equal parts of kerosene, molasses, and water. Emulsion thus formed would remain for some minutes, but gradually separate. This emulsion, applied September 10, 1885, killed cabbage worms of all kinds, Aphides, and other insects, provided it came in contact with them; but owing to their secreting themselves so fully within the leaves, many escaped. Even when applied so thoroughly as to kill the leaves of the plant, numbers of the worms would escape, and were seen afterwards as healthy as ever upon the plants treated with the emulsion. Not more than half the insects were killed by this treatment.

Cost of this application, one-fifth of a cent per cabbage, not counting time of making or applying.

Cold-water Application.—September 19, applied cold water from a well* direct to cabbage worms, at about 11 a. m.; day warm (77° F., at noon). Examinations later in the day showed no result. On the 21st, on plants thus treated were a number of dead larvæ, also many alive and healthy. Those dead had the appearance of worms dying from the micrococcus disease introduced from Illinois two years ago, and microscopic examination of the body contents showed them to be swarming with micrococci apparently the same as those in the disease of two years ago. Later many of these dead larvæ were found on plants not treated, so it

*Temperature of water in well here is about 40° F.

is uncertain whether the applications of water produced any effect. On September 21, at about 11.30 a. m. (temperature at noon, 81° F.), applied ice water to cabbage worms. Worms were decidedly disturbed when it came in contact with them, but I could get no positive evidence of any of them dying from its effects. On the plants thus treated the worms soon after began dying, as in the case of the first application of water; but as they also died on plants not treated, it is unsafe to conclude that this application induced the disease. On these plants worms died off till scarcely a living worm could be found. October 6, on farm of C. F. Mount, applied cold water to cabbage worms (day cool; at noon, 51° F.)—water cold enough to make the worms curl up and drop when it came in contact with them. Examined October 7, and could find none killed or dying from effect of this application.

Carbolic Acid in Water.—September 21, applied carbolic acid in water, very dilute (1 dram carbolic acid to 1 gallon water). An hour or two later no effect could be noted, nor on subsequent days. September 26, applied carbolic acid and water to plant-lice on squash and on cabbage, and to worms on cabbage and parsnips. Up to October 1 no effect was to be noted from this application. On October 6, on farm of C. F. Mount, applied carbolic acid and water (one-half ounce to gallon of water), sprinkling eighteen plants. On October 7, on plants thus treated a number of dead worms were found, but a considerable number had escaped. Professor Mount applied carbolic acid, about one-half ounce to one gallon of water, for the first brood of worms, and his cabbages were not injured till late in fall. He does not know that any were killed, but thinks it prevented injury.

Bran.—October 6, applied bran to cabbage plants on which worms were quite plenty. October 7, found the worms as numerous and apparently as healthy as before. Perhaps they avoid places where bran is thick.

Salt Solution.—September 21, this solution was applied to cabbages, on which were numerous worms and Aphides. Worms neither killed nor driven away. Aphides unaffected, except where they were washed off. The plants were watched until the 25th, and no result noted. The solution was also applied to Aphides on weeds, with no effect. Was also applied as a warm solution to Aphides on weeds, and some branches thickly covered with the insects were dipped into the solution, without effect on the Aphides that held to the plant. Some were washed off or crushed, but the colonies a few hours later and on following days were as thickly populated and as healthy as ever.

Saltpeter Solution.—September 21, applied saltpeter in solution to cabbages on which worms and Aphides were abundant. Neither seemed affected by the application. Up to September 25 there were no signs of injury. October 6, applied solution of saltpeter to eighteen cabbages on which worms were tolerably plenty. October 7, no effect to be seen; worms plenty and healthy.

Alum.—September 26, dusted pulverized alum on cabbages where worms and Aphides were abundant. Up to October 1 no effect was noted on either. September 26, it was applied in solution to them, but no signs of injury to either worms or Aphides were observed. October 6, applied to cabbages on which worms were plenty. October 7, worms as healthy and numerous as ever.

Kerosene in Ashes.—On October 4, applied this mixture to cabbage plants on which worms and Aphides were plenty, and watched for some time to see the effect. Could not find any worms killed by the application, though many were seen with the oily particles in contact with them on the leaves or adhering to their hairs. On subsequent days no decrease in numbers could be noted as a result of this application. Aphides were killed in some instances, but their position under leaves made it very difficult to dust them. The worms (*P. rapæ*) seem to be protected by their hairy covering, which prevents the particles from coming in direct contact with the skin, and renders the spreading of the oil less effective. The worms with smooth skin might be killed more readily, but they were not plenty enough on the plants treated to enable me to arrive at any positive conclusion.

Kerosene in Gypsum.—Applied on October 4, the gypsum containing as much kerosene as possible while allowing it to be dusted on the plants. The results were the same as followed the use of ashes, but I found it more difficult to mix and apply. There was a constant tendency to form lumps too large to be dusted on the plants, and unless quite fine the particles will simply roll off the leaves.

Kerosene in Sawdust.—Sawdust thoroughly saturated with kerosene was applied, October 17, to a number of plants on which cabbage worms were but moderately plenty. They were watched for nearly two hours, without any marked result. Unfortunately, I was prevented from making any further observations for several days, and in the meantime some severe frosts, the ravages of disease, and the maturing of the worms, left scarcely a living worm to be found even on plants not treated.

Tomato-vine Infusion.—Applied, October 7, to 18 cabbage plants infested with cabbage worms. The plants were thoroughly drenched with the infusion, and many of the worms were well soaked in it without apparent inconvenience to them. On the following day the plants thus treated were as badly infested as before and the worms were all vigorously feeding.

REPORT OF EXPERIMENTS AT TRENTON, NEW JERSEY.

By Thomas Bennett.

Trenton, N. J., *June* 15, 1885.

Sir: Under your direction I have tested the insecticide value, to a limited extent, of five of the six vegetable substances you gave me to experiment with. These were as follows: Jamestown weed (*Datura stramonium*); tomato leaves (*Lycopersicum esculentum*); Elder (*Sambucus*); Ailanthus; mandrake root (*Podophyllum peltatum*); and Tansy (*Tanacetum*).

At this date I have not been able to procure tomato leaves in sufficient quantity to experiment with; the others I have. The first insect that I found requiring attention was the green Aphis, or plant louse (*Myzus persicæ*), of the Peach, which was collected in great numbers on six young peach trees in my garden. They were only on the ends of the branches of the present summer's growth. I marked one tree, and prepared a decoction and also an infusion of tansy in the following manner:

Tansy.—June 5: weighed a handful of tansy, weight ½ pound; put it in three quarts of water; set on to boil; let it simmer an hour, then set away to cool. At the same time, made an infusion of ½ pound tansy by pouring on three quarts of boiling water, and set away to cool. This extract I found much the stronger of the two.

The leaves of the peach trees were so curled that I could not apply the liquid by other means than by dipping; besides, I wished to save my liquid. I dipped one side of the tree in the decoction, the other side in the infusion or extract. I found the liquid in both cases would wet the leaf but not the insects. They seemed covered with an oily substance which prevented the preparation in both cases from adhering to them; and it would roll off as water rolls from an oiled flag or piece of polished marble. Then I thought, as lye has an affinity for oils and grease, I would try lime-water and also urine, in the proportion of first one-quarter, then one-half; but although each proportion and each sort did some good, they were not satisfactory. However, the insects did not increase any, and I dipped them every day, for four days, and at this writing (June 15) there are few to be seen.

Elder Leaves.—June 7: made an infusion of elder leaves and tops, weight ½ pound; poured on two quarts of boiling water; set on back of range to draw; time, two hours. I had expected a good result from elder, as it has long been used by gardeners and farmers, combined with burdock and walnut leaves, &c., as an application against insects; but in this case it did not seem to work well. I marked another tree, and applied it by dipping the ends of the branches. The water rolled off as usual, and would not stick. I mixed a little alkaline lime-water, but it seemed not to injure them in the least. I noticed that the infusion was nauseous but not bitter. I cannot see how it acts as an insecticide unless by the smell. Some insects have a great dislike to pungent and strong smells. After the fourth dip, which was on the fourth day, I despaired of its doing any good in this case, and so tried my next remedy, which was mandrake root.

Mandrake Root.—June 8: made a decoction of mandrake root, 1 pound; put in two quarts of water; let it come to a boil, and then simmer or stew slowly for one hour. When cool it tasted very bitter and was rather dark colored, and I had good hopes of it, in which I was not disappointed. I applied it to another young peach tree, and also to a young, six-year-old cherry tree, infested with black Aphides (*Myzus cerasi*). Three dips almost cleaned them entirely from the peach tree, and also from the cherry tree, so that the Ladybug and her larvæ made short work of the few sickly ones that remained. I cannot account for it, but this wash seemed to take a better hold of the insects, so that the Peach Aphis would turn brown after the second dip; and in my subsequent experience I found that whenever the insects turned brown it was a sure indication that their time was short. They would not increase afterwards, and the Ladybug larvæ soon destroy them. I also tried this remedy on rose bush Aphis, with about the same result.

Ailanthus.—June 9: made an infusion of 8 ounces of the leaves of Ailanthus in two quarts of water; let it draw two hours. The liquor was very dark, and the infusion similar to elder in its effects; the water rolled off and would not adhere to the insects. An infusion of the bark was clear, only slightly brown. I added some lime-water, for the purpose mentioned in my first experiment, and also applied a little fine dust through a small dredging box. This made the infusion adhere very closely, and the Aphides succumbed after the third dip. It will be remembered in all these cases that I made only one dip each day, and waited till next day to see its effects; then dipped again. No one need be surprised that these different bitter and obnoxious plants had no better effect on these insects when I say that I afterwards tried two of the strongest vegetable bitters we know—namely, quassia and coloquintida, or the colocynth gourd—with no better effect.

I may here remark that I bottled and labeled all those bitters for other experiments.

N. B.—I have since found that the ailanthus bark contains the bitter principle very largely, but takes a long time to draw.

Stramonium.—June 10: made an infusion of 6 ounces of the leaves and young tops of Stramonium in 3 pints of water. Let it draw two hours. When cool I applied it as I did the others, by dipping the ends of the branches. The liquid was not bitter, but I depended on the effects of the poisonous narcotic principle, which, like its near relative, tobacco, it very largely contains. In this I was not disappointed, for, although it would not adhere very closely, the Aphides seemed to diminish and die after the third application; and if any scattering ones remained they were soon eaten up or destroyed by their enemies. I should note that a few rose bushes, infested with Rose Aphis (*Siphonophora rosæ*), were treated in a similar manner to the peach and cherry leaves, but the lice seemed somewhat harder to kill.

Alder Bark.—June 11: I thought I would try an infusion of alder bark, because it contained the tanning principle, which is an astringent, and as all astringents, whether vegetable or mineral, are more or less insecticidal in their nature, I thought that perhaps it might be of some value. I found it had some effect as an insecticide, but as the infusion is very dark, almost as black as ink, and discolors the leaves a good deal, I left it off and do not recommend it.

Quassia.—June 11: made an infusion or extract of quassia chips or bark, ground fine. These are made more nicely prepared than formerly. Gardeners know well the power of this bitter, in greenhouses and graperies, in keeping down Green Fly, as they call it (*Siphonophora viticola*), also Thrips (*Erythroneura*), and Red Spider (*Tetranychus*). I poured two quarts of boiling water on four ounces of quassia. This made a strong infusion of a beautiful brown color, similar to the tea we use from the shops. I thought surely this would kill at the first dip, but it did not, though very bitter. It took three dips of this strong liquid to kill these Aphides on the Peach, the Cherry, and the Rose, and then there were some stragglers around, of which I could not be sure whether they escaped from the effects of the dipping, or came in from other parts of the tree or rose bush.

Coloquintida, or Colocynth Gourd.—June 11: this bitter principle I have formerly used to a limited extent, in greenhouses, and have a high opinion of its merits; but quassia being so much cheaper and generally effective, I have mostly used it. However, I procured an ounce of colocynth, ground it up, and put on nearly a pint of boiling water, and drew it as tea. It is very powerful as a bitter, but it took three dips to eradicate the Aphides from the rose bush, peach, and cherry trees.

Further Experiments.—Monday, June 15: went out a short distance in the country, about one mile east of Trenton, to the lands occupied by Mr. James McGrath, who is an extensive cabbage-grower, and got liberty to make some tests with a view to preventing the cut-worm from injuring the young cabbages. I had previously learned that he was going to plant on this day. Was allotted a piece to experiment on, that contained

60 plants to each row. I poured on the stems and lower ends of the leaves of

Row No. 1: Mandrake infusion;
Row No. 2: Elder infusion;
Row No. 3: Stramonium infusion;
Row No. 4: Ailanthus infusion;

and, Tansy being plentiful on the place, I made a strong infusion of it, and wetted over 1,000 plants which were to be planted on another part of the lot. I also made a solution of

Alum, 2 ounces to 1 pint of water;
Niter, 2 ounces to 1 pint of water;
Saleratus, 4 ounces to 1 pint of water;
Lime water, 4 ounces to one quart of water;

and applied these strong liquids to rows 5, 6, 7, and 8, which together made 9 tests or experiments.

I did not examine these for results till June 29. The Tansy seemed to show the best results, and I could only find 4 plants eaten off by cut-worms.

The saleratus had been strong, and killed several plants, and I could not pronounce any of the other experiments entirely successful.

Mr. McGrath had lost many plants in this lot of about four acres by cut-worms during the last two weeks.

June 17: tried the effect of infusion of Ailanthus, Tansy, Elder, and mandrake, sprayed on with a brush by drawing the hand lightly over the brush till all the leaves were wetted. These did not give very satisfactory results, though partially effective. Next day, I thought I would assist them with some cheap powders. I procured some gas-lime, and sifted it; and also made a powder of gas-tar and lime, then sifted. This last was composed of ½ ounce of tar to 1 pound of lime. I also made a preparation of quicklime, well sifted. After spraying the vines, and making a number for each experiment, I proceeded thus—

No. 1. Elder leaves, followed by a dusting of gas-house lime.
No. 2. Stramonium, followed by a dusting of tar lime.
No. 3. Mandrake, followed by a pure lime dust.
No. 4. Tansy water, followed by pure lime dust.
No. 5. Ailanthus leaves tea, followed by gas-house lime.
No. 6. Ailanthus leaves tea, followed by tar lime.
No. 7. Ailanthus, followed by pure lime.
No. 8. Lime water alone, as a thin whitewash.
No. 9. Niter water alone, 2 ounces to 1 pint of water.
No. 10. Alum water alone, 2 ounces to 1 pint of water.
No. 11. Saleratus, 4 ounces to 1 pint of water.
No. 12. Gas lime and pure lime, mixed in equal quantities.
No. 13. Tar lime alone.
No. 14. Pure lime alone.

I had never seen potato vines more thickly covered with bugs than these were when I commenced with them, owing to the fact of the

owner having removed to the other side of the city, and not having time to attend to them. On Saturday, June 20, there were no bugs there. I did not see them again till June 28, then I saw only 5 bugs on the lot. I have given them another sprinkling of tar lime since then, and there is not a bug to be found. I am sure they never got a particle of Paris green.* As many persons have an objection to putting Paris green on potatoes, I can recommend a dead shot made of one pint of gas tar to 1 peck of lime as an effectual remedy against potato bugs.

July 15, 1885.—As you directed, I have continued through this month to make experiments with the six vegetable substances you advised, namely, Ailanthus, Tansy, stramonium, Elder, mandrake, and tomato.

Before I proceed further, I wish to say that during the fore part of this month I succeeded in cleaning a few hop vines in my yard and those of some of my neighbors from two species of a destructive caterpillar, and also a species of Coreus or Stink Bug, which was doing much harm by sucking and killing the leaves of the vines. I herewith send specimens of the bug and the caterpillar.† I made a powder of gas tar and lime, which soon cleared the vines of every insect, and now there are none to be found on them. I find this powder is good also for every species of Plant-louse.

July 6.—Collected these leaves and plants, and made strong infusions. First tried them on the Cabbage Cut-worms, by burying a worm one-half inch deep and within 1 or 2 inches of each cabbage plant, wetting them thoroughly with each liquid, and labeling each one. At the same time I tried Hansen & Smith's Pinoleum, diluted with 25 parts of water. Next morning, when I went to examine my plants, I found the worms had all moved away but one; this one had been wetted with tansy, was curled up in the usual way, and apparently in good health. It was evident, however, they did not like their situation, for only one ventured to cut his plant, and that was the one wetted with elder; he was also gone.

I next tried the effect of these infusions on the Jumping Flea-beetle (*Haltica*), on Early Dutch cabbages. Most of them proved very good, but were most effectual when followed by a dusting of lime powder or plaster.

The liquid adheres better after the garden syringe than the watering pot. Infusions of ailanthus leaves and also of stramonium I have used in former years for this and green fly and cabbage lice with good effect, but they were mostly followed by a dusting of lime in fine powder. I would remark just here that tobacco dust, lime powder, plaster, ashes, or soot well mixed with five or six times its bulk of charcoal dust, or in fact any other dust, will effectually keep off the Jumping-bug, if the ground around the plants be kept stirred; and here is where many fail in applying these powders; they do not seem to be aware that it is necessary to stir the

*I should note that the saleratus was too strong, and killed part of the leaves of the potatoes as well as the bugs.

†These insects were *Agrotis malefida*, *Arctia virginica*, and *Coreus tristis*.—C. V. R.

ground often around the plants. If a field of turnips or a bed of cabbages, when just coming over the ground, be only lightly stirred, by drawing a garden rake over the plants, along close to the rows, there will be very little if any powder required, but this must be done often to keep down this bug; and in this the secret of saving the crop lies, of which few seem to be aware. These bugs seem to breed in and come from the ground around the plants, but, it seems, cannot generate if the ground be kept frequently stirred. This I have proved to my entire satisfaction; and when the ground cannot be stirred, all of the above powders will often fail.

I next tried the effect of these infusions on cabbage lice (*Aphis brassicæ*) on about 200 plants. Here, again, I found it was essential to follow with the lime powder, for although these washes killed some and stunned most of the others, yet it had not the powerful effect of the lime powder. This, as far as I have gone, has proved effectual, and I think if put on in time will keep down this pest altogether.

During this month I have also been trying to find out something to prevent the Cut-worm from injuring cabbages after being planted. I have tried soft soap and tobacco water separately and combined, as a dip, also Hansen & Smith's Pinoleum in 12 times its volume of water. They were all too strong and killed many of the plants at first. Nothing daunted, I tried again, at least the soap and tobacco. Infused two ounces of tobacco stems in one quart of water, as a dip for the stems and lower ends of the leaves. Also made a suds of one teaspoonful of soft soap to one pint of water. With each of these I wetted 25 cabbage plants, and placed a Cut-worm in the ground near the stem of each. This was done a week since, and I have had none of these cut yet, and they continue to be cut in a field of 14 acres near by. The owner has only saved this lot of cabbages by keeping boys constantly searching for and killing the grubs around the plants and occasionally transplanting. I also tried a plan of former days, by putting a little freshly slacked sifted lime around 115 plants, with this exception, that in order to make the test good I buried 12 Cut-worms, about one-half inch deep, and from one to two inches from the stems of each of a dozen plants. I have seen them every day for more than a week, and I have not found one plant cut yet. I have also tried the effect of these infusions on the Slug (*Selandria*), a small soft-bodied caterpillar I found on pear and cherry trees. Syringed the branches, and wetted them well. The stramonium water was the most powerful; seemed to kill at once, but next day I found many yet on the leaves. I then gave them a dusting of lime powder, and that completely banished them.

I formerly used a powder of ailanthus and also of stramonium leaves to eradicate this pest from fruit trees, but of late years I find lime powder, well sifted and dusted on, involves less labor, and is a most effectual remedy against this pest.

I find cabbage-growers in general make a great mistake by plant-

ing too deep. They put nearly all the stem into the ground; this gives easy access to the Cut-worm to destroy the heart of the cabbage; they would do much better not to plant so deep, especially the late-grown kinds, as the hard stem is less liable to be cut than the heart of the cabbage.

July 31, 1885.—In your favor of the 17th instant you requested me to continue my experiments as heretofore with infusions of Tansy, Ailanthus, stramonium, Mandrake root, Elder, and tomato leaves, in order to give a definite answer as to which may be of value as an insecticide and which are worthless. I beg leave to say I have gone to work very willingly to try to answer this important question, and made tests on various insects.

As most of the above plants are now easily procured, I made infusions in large quantities, but of about the same strength as heretofore. I find it is better to let these leaves dry two or three days before the infusions are made. These liquids seem also to gain strength by age. At a week or ten days old they are much stronger than when first made. One pound weight of the partially dried leaves to one gallon of water makes a good wash. I first tried the relative value of these infusions on some brown and yellow hairy caterpillars, the larvæ of a Bombycid moth (*Arctia virginica*), 1½ to 2 inches long, which had been very plenty in this locality, on the Sunflower. I marked a certain number of plants for each test, and sprayed and wetted both sides of each leaf thoroughly. They all continued to eat the leaves after this as before; but with those sprayed with ailanthus, stramonium, and mandrake not nearly so ravenously—they seemed rather dainty in their biting.

Next day I wetted again as before, with about the same result; but when I wetted the worms thoroughly with stramonium they fell off and crawled away, and seemed not to ascend the plant any more.

Then, in order to satisfy myself as to the merits of the different liquids, I collected a number of these caterpillars and placed them in six groups, on a short piece of board. I wetted them all over equally. They were all able to crawl out of their bath; but, when I pushed them back and wetted their heads, they did not get out again from either mandrake, ailanthus, or stramonium. The others crawled out of several wettings; but these remained on the board, and were dead next day.

About the middle of the month I sowed a patch of white turnips in drills, for the purpose of testing these liquids on the Turnip Fly (*Haltica*). They were up in about four days. I commenced wetting them; not all, but part of each of six rows. I found it was necessary to wet them every day for a week, and afterwards two or three times, before they got ahead, in order to keep down this pest; and where I did not wet them they were all eaten off in about seven or eight days, and I could not say positively which of these liquids was the best.

I tried these infusions also on the Grape-vine Thrips, on an outdoor arbor, and both sides of the leaves had to be wetted. In this case the

stramonium and tansy seemed the best, but the leaves had to be well drenched twice, and in some cases three times, before the insects forsook them or were all killed.

I have also tried the effects of these washes on the Cabbage Louse (*Aphis brassicæ*). These seem easier killed now than about the beginning of this month. Each liquid seems to have a better hold of them than at first, and two applications killed them all on every head to which these washes were applied. I sprayed 12 heads, two to each liquid used.

I also tried the power of these infusions on some cucumber vines, to see what effect they would have on the Striped Cucumber Beetle (*Galeruca*), and find that unless these washes are very plentifully applied they will have but little effect on this bug.

On the 24th of this month I procured six Cabbage Cut-worms, and put one near the stem of each of six cabbage plants, and placed it about one inch under ground. I then placed a common tomato can over each plant and sunk it in the earth about one-half its depth. I had previously cut off both ends smoothly with a pair of scissors; then about one-half pint of liquid was poured into the can around each plant, and this wetted the ground, I should say, about three inches. The following night the plant wetted with elder was cut off by its worm, and the fourth night, the 28th instant, another, marked "Ailanthus," was cut; but since then no more have been cut.

My object in this experiment was to find out, if possible, the real value of each of these infusions as a preventive to the Cut-worm; for if some will not cut at all, after being starved, as it were, in prison, I think that wash may be depended on.

These infusions have been taken on their merits alone, and I do say they all have some good properties as insecticides. I do not think much in general of tomato leaves, nor Elder alone; nor do I think Mandrake will ever become popular, from the fact of the extra labor and difficulty of collecting and preparing it. Tansy, Ailanthus, and stramonium are the best, in my opinion, and of these three stramonium stands the highest in my estimation.

I have to thank Professor Riley very much for assistance rendered in determining the species of many insects in these and many other tests performed by me.

Most respectfully,

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